Oct. 1, 1957 J. D. DURANT ET AL 2,808,004

PUMPING MECHANISM

Filed Feb. 19, 1952 2 Sheets-Sheet 1

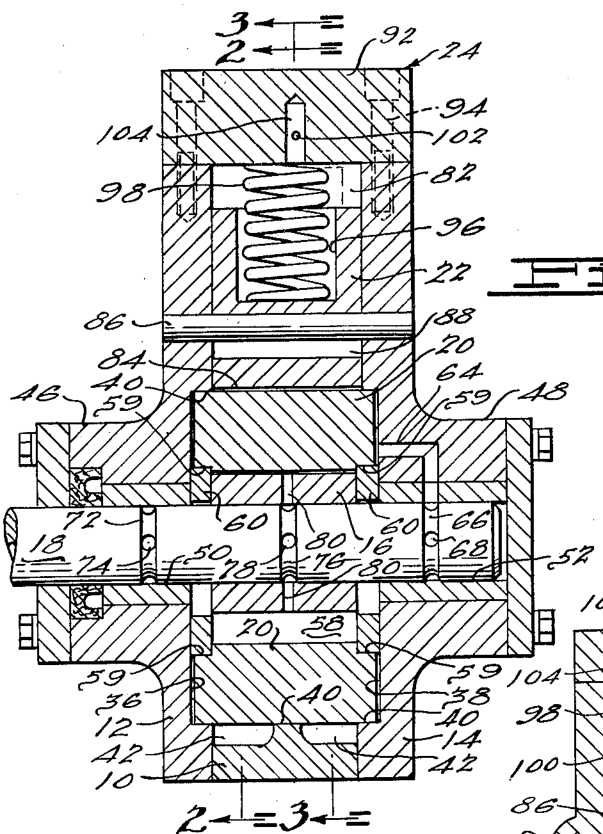

FIG. 1.

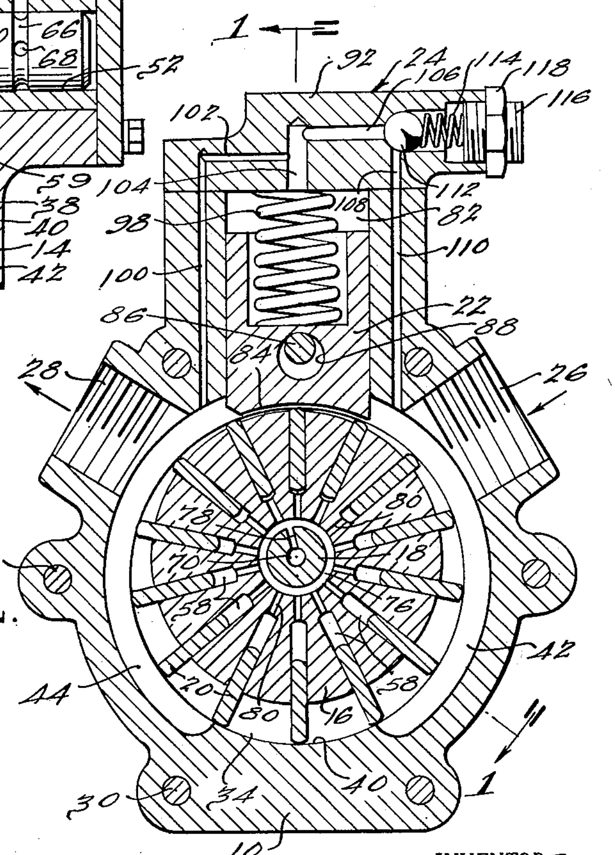

FIG. 2.

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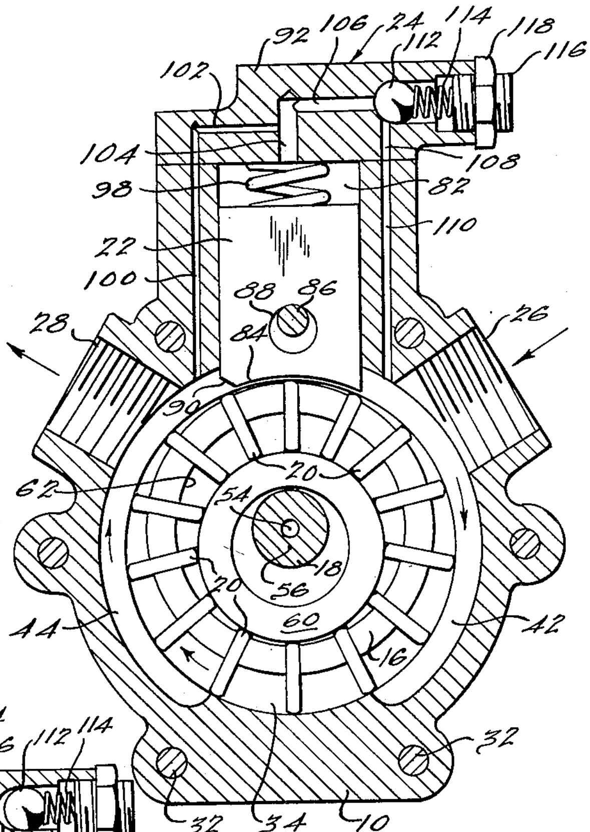

FIG. 3.

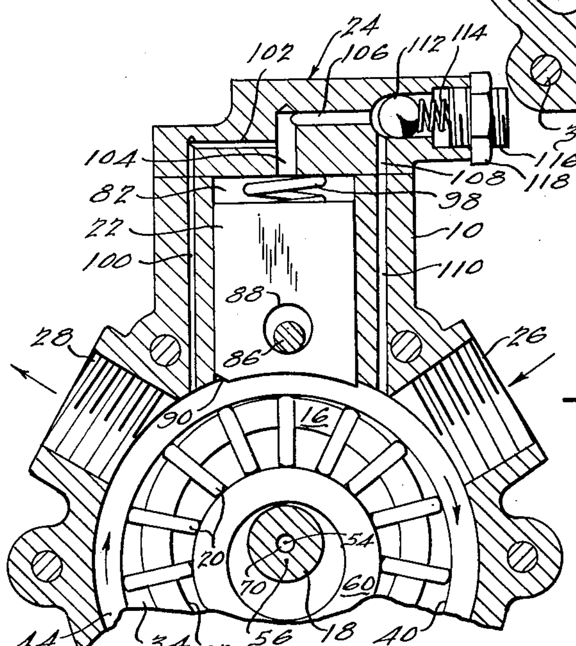

FIG. 4.

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PUMPING MECHANISM

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Application February 19, 1952, Serial No. 272,282

12 Claims. (Cl. 103—42)

The present invention relates to a pumping mechanism and more particularly to an improved rotary vane type variable delivery pump.

The pumping mechanism of the present invention is adapted to operate at variable speeds and is designed to maintain a substantially constant discharge pressure. It is also a pump of the type in which the pumping action of the pump decreases as the delivery requirements decrease so that power of the engine or other prime mover used to drive the pump is not wasted in useless circulation of the liquid as is common in many pumps which simply by-pass the excess liquid. In addition to wasting horsepower in the unnecessary circulation of liquid these by-pass type pumps also churn and heat up the liquid unduly, making necessary the use of expensive additives to the liquid to minimize the detrimental effects of the churning and heat generation. Also, it will be appreciated that pumps of the present type eliminate the costly by-pass valve which in the above mentioned by-pass type pump must be capable of handling the full volume of the pump and are very expensive compared to the cost of the pump.

It is an object of the present invention to provide an improved rotary vane type variable delivery pump, the pumping action of which automatically varies with the delivery requirements.

It is also an object of the present invention to provide an improved pump of the above mentioned type which is simple in design, economical of manufacture and reliable and efficient in operation.

It is a further object of the present invention to provide an improved pump of the above mentioned type having novel and improved means for positioning the vanes and providing a seal preventing the leakage of the liquid being pumped past the ends of the rotor.

Another object of the present invention is to provide an improved pump of the above mentioned type including a movable segment defining a portion of the wall of the pumping chamber and which is urged toward the position of maximum delivery by resilient means supplemented by hydraulic pressure supplied from the discharge side of the pump.

It is also an object of the present invention to provide a pump of the just mentioned type including means for automatically relieving the just mentioned hydraulic pressure supplementing the resilient means, when this hydraulic pressure reaches a predetermined maximum.

Other and more detailed objects of the present invention will be apparent from a consideration of the following specification, the appended claims and the accompanying drawings wherein:

Figure 1 is a sectional view showing a pump embodying the present invention and taken substantially along the line 1—1 of Figure 2;

Figure 2 is a sectional view of the pump illustrated in Figure 1, taken substantially along the line 2—2 thereof;

Figure 3 is a sectional view of the structure illustrated in Figure 1, taken substantially along the line 3—3 thereof; and,

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Figure 4 is a broken sectional view similar to the upper portion of Figure 3 and showing the position of the parts at zero delivery from the pump.

Referring to the drawings, the pump generally comprises a central pump body **10**, a front plate **12**, a rear plate **14**, a rotor **16** disposed within the pump body **10** and carried on a shaft **18** journaled in the front and rear plates **12** and **14**, a plurality of vanes **20** carried by the rotor **16**, a block **22** movable to vary the delivery of the pump and means generally indicated at **24** for automatically positioning the block **22** to conform to the changes in the delivery requirements.

Considering the above mentioned elements in greater detail, the pump body **10** has an inlet opening **26** and an outlet opening **28** and co-operates with the front and rear plates **12** and **14**, which are secured thereto by any suitable means such as screws **30** and **32**, to define a central pumping chamber **34**. This pumping chamber is cylindrical in shape and includes a pair of spaced parallel side walls **36** and **38** formed on the front and rear plates **12** and **14** respectively, and a cylindrical wall **40**. As best illustrated in Figure 1, the opposite end portions of the cylindrical wall **40** are formed in the front and rear plates **12** and **14** and the intermediate portion of this cylindrical wall **40** is formed in the pump body **10**. The inlet **26** communicates with the pumping chamber **34** through a pair of arcuately extending recesses **42**, and the outlet **28** similarly communicates with the pumping chamber **34** through a pair of arcuately extending recesses **44**. These recesses **42** and **44** are formed in the intermediate portion of the cylindrical wall **40** defined by the pump body **10**, as best illustrated in Figure 1.

The front and rear plates **12** and **14** have oppositely extending bosses **46** and **48** in which are carried aligned bearings **50** and **52** respectively, in which the shaft **18** is journaled for rotation about an axis **54** spaced from and parallel to the axis **56** of the cylindrical wall **40**. The rotor **16** is secured to the shaft **18** for rotation therewith and disposed within the cylindrical pumping chamber **34**. The rotor **16** is cylindrical in shape, and of a diameter substantially smaller than that of the cylindrical wall **40**. The rotor **16** also has a plurality of equiangularly spaced radially extending slots **58** in which the vanes **20** are mounted. The vanes **20** are or a length, measured along the axis of the shaft **18**, slightly less than the distance between the end faces **36** and **38** of the pumping chamber **34**.

As best illustrated in Figure 1, the vanes **20** are notched at their inner edges at the opposite ends thereof, as indicated at **59**, to receive guide rings **60** which bear against the end walls **36** and **38** of the pumping chamber. These guide rings **60** serve as thrust rings and position the vanes **20** between and out of contact with the end walls **36** and **38**. These guide rings **60** have an external diameter adapted to closely fit within the notches **59** when the vanes **20** are disposed with their radially outer edges in contact with the cylindrical wall **40** of the pumping chamber **34**. The opposite ends of the rotor **16** are undercut to provide an axially inwardly extending central recess **62** adapted to receive the guide rings **60** and permit the movement of these guide rings **60** transversely of the axis of the rotor **16** which accompanies operation of the pump. The guide rings **60** also act as a seal preventing leakage of liquid from the outlet side of the pump past the end of the rotor **16** and to the inlet side.

In the preferred embodiment illustrated, the bearings **50** and **52** are lubricated by the liquid being pumped. For this purpose a passage **64** is formed in the rear plate **14** with one end thereof opening into the pumping chamber at any suitable place on the pressure side of the pump and having its other end opening radially through the bearing **52**. The shaft **18** has an annular groove **66** aligned with the last mentioned end of the passage 64 and a radially extending passage 68 which connects the annular groove 66 with a centrally disposed axially extending passage 70 formed in the shaft 18. The bearing 50 is lubricated from an annular groove 72 in the outer surface of the shaft 18 which communicates with the central passage 70 by means of a radially extending passage 74.

Intermediate the bearings 50 and 52, the shaft 18 has another annular groove 76 in its outer surface which communicates with the central passage 70 by means of a radially extending passage 78. Referring to Figures 1 and 2, the rotor 16 is provided with a plurality of radially extending passages 80 individual to the vane receiving slots 58. These passages 80 connect the slots 58 with the annular groove 76 to supply liquid under pressure to the vane receiving slots 58 and hold the vanes in contact with the cylindrical wall 40 of the pumping chamber 34.

The pump body 10 and the front and rear plates 12 and 14 define a chamber 82 of rectangular cross section disposed at the upper side of the pump as illustrated in the drawings, and extending at right angles to the axis of the pumping chamber 34. The movable block 22 is mounted within the chamber 82 and of a cross-sectional shape adapted to fit the chamber 82 for sliding movement longitudinally thereof. The lower surface of the block 22, indicated at 84, is cylindrical and has a radius of curvature equal to that of the cylindrical wall 40 which is, of course, interrupted at the movable block 22 and the surface 84 at the inner end of the block 22 constitutes a portion of the wall of the pumping chamber 34. The block 22 is movable between a first position illustrated in Figures 1, 2 and 3 corresponding to maximum volume delivery of the pump and in which the cylindrical surface 84 closely approaches but is spaced slightly radially outwardly from the adjacent portions of the cylindrical wall 40, and a second position illustrated in Figure 4 and corresponding to zero volume delivery from the pump. Movement of the block 22 beyond these limits is prevented by a pin 86 extending through and supported in the front and rear plates 12 and 14, and which extends through an enlarged opening 88 formed in the block 22. Since the pin 86 prevents movement of the block 22 beyond the position illustrated in Figures 1, 2 and 3, there will at all times be at least the small space illustrated in these figures between the surface 84 of the block 22 and the adjacent of the vanes 20. This insures the exposure of the surface to liquid under a pressure substantially equal to the discharge pressure of the pump. Adjacent the outlet 28 the lower corner of the block 22 is relieved as indicated at 90 to also facilitate the exposure of the surface 84 of the block 22 to liquid under a pressure substantially equal to the discharge pressure of the pump.

The outer end of the chamber 82 is closed by a cover plate 92 secured in place by the screws 94. The block 22 has a recess 96 in its outer end. A coil spring 98 has one end received in the recess 96 and acting against the block 22 and its other end bearing against the cover plate 92. The spring 98 yieldably holds the block 22 in the position illustrated in Figures 1, 2 and 3. The action of the spring 98 is supplemented by hydraulic pressure exerted on the outer end of the block 22 by liquid supplied to the chamber 82 through a passage 100 formed in the pump body 10 and extending from one of the recesses 44 at a point adjacent the outlet 28 upwardly, as viewed in the drawings to the upper end of the pump body 10. The cover 92 has a passage 102 connecting the passage 100 with a passage 104 opening into the chamber 82. The passage 104 also connects with another passage 106. The cover 92 also has a passage 108 connecting with a passage 110 formed in the pump body 10 and opening into one of the recesses 42 adjacent the inlet 26. The cover 92 also carries valve means for controlling communication between the passages 106 and 108 and adapted to automatically establish such communication when the pressure within the passage 106 exceeds a predetermined value. In the embodiment illustrated this valve means comprises a spherical valve element 112 yieldably urged to the seated position illustrated in Figures 1, 2 and 3, in which it closes one end of the passage 106, by a coil spring 114. To provide for the desired preloading of the spring 114, and adjustment thereof as desired, a set screw 116 is threadedly mounted in the cover 92 and engages the outer end of the spring 114. The set screw 116 is locked in adjusted position by a nut 118 threaded on the screw 116 and abutting the cover 92.

The proportions of the passages 100, 102, 104, 106, 108 and 110 are such that upon the pressure in the passage 106, and hence in the chamber 82 to which it is directly connected by the passage 104, reaching a value sufficient to produce an unseating of the ball valve 112, a drop in the pressure within the chamber 82 results. In the construction illustrated the cross-sectional area of the passages 100 and 102 are substantially less than those of the passages 104, 106, 108 and 110. The strength of the spring 98 is such that upon an unseating of the ball 112 and the accompanying drop of pressure in the chamber 82, the pressure exerted on the inner end of the block 22 at the cylindrical surface 84 thereof exceeds the pressure exerted on the block 22 by the reduced hydraulic pressure in the chamber 82 and produces a movement of the block 22 upwardly as viewed in the drawings and producing a further compression of the spring 98. This movement of the block upwardly permits a flow of liquid from the pressure side of the pump, at which the outlet 28 is located, to the intake side of the pump between the outer edges of the vanes 20 and the cylindrical surface 84 at the inner end of the block 22. The volume of this flow is dependent upon the degree of movement of the block 22 and rapidly reduces the delivery of the pump.

In operating the pump, the set screw 116 is adjusted to produce a preloading of the spring 114 sufficient to hold the ball valve 112 seated until a predetermined desired discharge pressure is produced at the outlet 28. When this pressure is reached the hydraulic pressure within the passage 106 overcomes the action of the spring 114 and unseats the ball 112. This results in an upward movement of the block 22 producing an accompanying reduction in the delivery of the pump. In some pump applications there are periods when the delivery requirements from the pump are zero. Upon use of the above described pump in such applications the block 22 will move upwardly to the position illustrated in Figure 4 and the ball valve 112 will move to the unseated position there illustrated. During these periods no liquid is drawn in through the inlet 26 nor discharged through the outlet 28. A part of the liquid which is carried from the intake side of the pump to the pressure side of the pump between the vanes 20 circulates through the passages 100, 102, 104, 106, 108 and 110 and maintains the ball 112 in the unseated position there illustrated and the remaining part of this liquid flows from the pressure side of the pump to the intake side of the pump between the rotor 16 and the cylindrical surface 84 at the inner end of the block 22. It will thus be appreciated that during this time there is very little liquid circulated and very little work done and accordingly, very little power is required for driving the pump. Upon an increase in the delivery required from the pump the block 22 returns toward the full capacity position illustrated in Figures 1, 2 and 3 as required to provide the volume of liquid to be delivered.

It will be appreciated, of course, that for any given application the pump is so designed that when running at the minimum speed at which it will be operated, it will have a volume delivery equal to the maximum delivery desired.

It will also be appreciated that this pump design may be used in connection with extremely high pressure ranges by properly relating the cross-sectional area of the passage **106**, the strength of the spring **114** and the strength of the spring **98**.

It will also be noted that the spacing and hence the number of the vanes **20** has an important relation to the pressure which the liquid within the pump exerts on the cylindrical surface **84** of the movable block **22**. In the preferred embodiment illustrated the construction of the pump is such that the cylindrical surface **84** at the inner end of the block **22** is approximately equal to a segment of the rotor **16** defined by three adjacent vanes **20**.

While only one specific embodiment of the invention has been illustrated and described in detail, it will be readily appreciated by those skilled in the art that numerous modifications and changes may be made without departing from the spirit of the invention.

What is claimed is:

1. A variable delivery pump mechanism comprising means defining a pumping chamber, a rotor mounted for rotation in said pumping chamber, a plurality of vanes carried by said rotor, said means including a member disposable in one position corresponding to maximum volume delivery of said pump and movable in one direction from said position to reduce the delivery of said pump, said member being exposed to a pressure within said chamber related to the discharge pressure of said pump and urging said member in said one direction, resilient means urging said member in the opposite direction, means for supplying hydraulic pressure from the high pressure side of said pump to supplement said resilient means, and means for automatically relieving said hydraulic pressure supplementing said resilient means when the discharge pressure of said pump reaches a predetermined pressure.

2. A variable delivery pump mechanism comprising means defining a pumping chamber, a rotor mounted for rotation in said pumping chamber, a plurality of vanes carried by said rotor, said means including a member defining a part of the wall of said pumping chamber and having a portion co-operating with said vanes to restrict the movement of liquid therebetween from the high pressure side of said pump mechanism to the low pressure side thereof, said member being disposable in one position corresponding to maximum volume delivery of said pump and movable in one direction from said position to reduce the delivery of said pump and increase the space between said portion of said member and said rotor, said member being exposed to a pressure within said chamber related to the discharge pressure of said pump and urging said member in said one direction, resilient means urging said member in the opposite direction, means for supplying hydraulic pressure from the high pressure side of said pump to supplement said resilient means, and means for automatically relieving said hydraulic pressure supplementing said resilient means when the discharge pressure of said pump reaches a predetermined pressure.

3. A variable delivery pump mechanism comprising means defining a pumping chamber, a rotor mounted for rotation in said pumping chamber, a plurality of vanes carried by said rotor, said means including a member defining a part of the wall of said pumping chamber and having a portion co-operating with said vanes to restrict the movement of liquid therebetween from the high pressure side of said pump mechanism to the low pressure side thereof, said member being disposable in one position corresponding to maximum volume delivery of said pump and movable in one direction from said position to reduce the delivery of said pump and increase the space between said portion of said member and said rotor, said member being exposed to a pressure within said chamber related to the discharge pressure of said pump and urging said member in said one direction, resilient means urging said member in the opposite direction, means for employing the hydraulic pressure at the high pressure side of said pump for exerting a force on said member supplementing said resilient means and substantially equal and opposite to the force exerted on said member by the pressure within said chamber, and means for automatically reducing said first named force when the discharge pressure of the pump reaches a predetermined pressure.

4. A variable delivery pump mechanism comprising means defining a pumping chamber and a second chamber disposed at right angles to said pumping chamber, a rotor mounted for rotation in said pumping chamber, a plurality of vanes carried by said rotor, said means including a member having a portion extending into and slidably mounted in said second chamber, said member including a surface forming a part of the wall of said pumping chamber, said member being disposable in a first position corresponding to maximum delivery of said pump mechanism and movable in one direction to reduce the delivery of said pump, resilient means urging said member to said first position, said first named means also defining passage means connecting said second chamber to said pumping chamber at the high pressure side of said mechanism and additional passage means adapted to vent said second chamber to a low pressure area, and valve means controlling the flow of liquid in said additional passage means and yieldably urged toward its closed position, said valve means being adapted to open, when the pressure in said additional passage means exceeds a predetermined value, to permit a drop in the pressure within said second chamber and a movement of said member in said one direction in response to the pressure within said pumping chamber acting on said surface.

5. A variable delivery pump mechanism comprising means defining a pumping chamber and a second chamber disposed at right angles to said pumping chamber, a rotor mounted for rotation in said pumping chamber, a plurality of vanes carried by said rotor, said means including a member having a portion extending into and slidably mounted in said second chamber, said member including a surface forming a part of the wall of said pumping chamber, said member being disposable in a first position corresponding to maximum delivery of said pump mechanism and movable in one direction to reduce the delivery of said pump, resilient means urging said member to said first position, said first named means also defining passage means connecting said second chamber to said pumping chamber at the high pressure side of said mechanism and additional passage means adapted to vent said second chamber to a low pressure area, and valve means controlling the flow of liquid in said additional passage means and yieldably urged toward its closed position, said valve means being adapted to open, when the pressure in said additional passage means exceeds a predetermined value, to permit a drop in the pressure within said second chamber and a movement of said member in said one direction in response to the pressure within said pumping chamber acting on said surface, said surface of said member being spaced slightly outwardly from the path of movement of said vanes when said member is in said first position.

6. A variable delivery pump mechanism comprising means defining a pumping chamber and a second chamber disposed at right angles to said pumping chamber, a rotor mounted for rotation in said pumping chamber, a plurality of vanes carried by said rotor, said means including a member having a portion extending into and slidably mounted in said second chamber, said member including a surface forming a part of the wall of said pumping chamber, said member being disposable in a first position corresponding to maximum delivery of said pump mechanism and movable in one direction to reduce the delivery of said pump, resilient means urging said member to said first position, said first named means also defining passage means connecting said second chamber to

said pumping chamber at the high pressure side of said mechanism and additional passage means adapted to vent said second chamber to a low pressure area, and valve means controlling the flow of liquid in said additional passage means and yieldably urged toward its closed position, said valve means being adapted to open, when the pressure in said additional passage means exceeds a predetermined value, to permit a drop in the pressure within said second chamber and a movement of said member in said one direction in response to the pressure within said pumping chamber acting on said surface, said passage means and said additional passage means being of a cross-sectional area such that an opening of said valve means resulting in a differential hydraulic pressure urging said member in said one direction.

7. A variable delivery pump mechanism comprising means defining a pumping chamber and a second chamber disposed at right angles to said pumping chamber, a rotor mounted for rotation in said pumping chamber, a plurality of vanes carried by said rotor, said means including a member having a portion extending into and slidably mounted in said second chamber, said member including a surface forming a part of the wall of said pumping chamber, said member being disposable in a first position corresponding to maximum delivery of said pump mechanism and movable in one direction to reduce the delivery of said pump, resilient means urging said member to said first position, said first named means also defining passage means connecting said second chamber to said pumping chamber at the high pressure side of said mechanism and additional passage means for connecting said second chamber to the low pressure side of said pump, and valve means mounted in said first named means for controlling flow through said additional passage means and yieldably urged to its closed position, said valve means being adapted to open, when the pressure in said additional passage means exceeds a predetermined value, to permit a drop in the pressure within said second chamber and a movement of said member in said one direction in response to the pressure within said pumping chamber acting on said surface.

8. A variable delivery pump mechanism comprising means defining a pumping chamber and a second chamber disposed at right angles to said pumping chamber, a rotor mounted for rotation in said pumping chamber, a plurality of vanes carried by said rotor, said means including a member having a portion extending into and slidably mounted in said second chamber, said member including a surface forming a part of the wall of said pumping chamber, said member being disposable in a first position corresponding to maximum delivery of said pump mechanism and movable in one direction to reduce the delivery of said pump, resilient means urging said member to said first position, said first named means also defining passage means connecting said second chamber to said pumping chamber at the high pressure side of said mechanism and additional passage means adapted to vent said second chamber to a low pressure area, and valve means controlling the flow of liquid in said additional passage means and yieldably urged toward its closed position, said valve means being adapted to open, when the pressure in said additional passage means exceeds a predetermined value, to permit a drop in the pressure within said second chamber and a movement of said member in said one direction in response to the pressure within said pumping chamber acting on said surface, the projected area, on a plane at right angles to the line of movement of said member, of the portion of said member within said second chamber being equal to the projected area on said plane of said surface of said member.

9. A variable delivery pump mechanism comprising a housing defining an inlet, an outlet, a cylindrical chamber, arcuate recesses extending circumferentially of said chamber and connecting said inlet and said outlet with said cylindrical chamber, and a second chamber extending at right angles to and intersecting said cylindrical chamber between the adjacent ends of and communicating with said recesses, a rotor mounted within said cylindrical chamber for rotation about an axis parallel to and spaced from the axis of said cylindrical chamber in a direction toward said second chamber, a plurality of vanes mounted in said rotor, means holding said vanes in engagement with the cylindrical surface of said cylindrical chamber during rotation of said rotor, a member slidably mounted in said second chamber and movable in one direction from a first position in which it co-operates with said vanes to substantially prevent liquid flow between said adjacent ends of said recesses, to permit said liquid flow in increasing quantities, resilient means urging said member toward said first position, the surface at the inner end of said member being exposed to a hydraulic pressure related to the discharge pressure of the mechanism and urging said member in said one direction, means connected to the high pressure side of the mechanism for supplying liquid under pressure to said second chamber to act against the opposite end of said member and supplement said resilient means, and means for automatically relieving the pressure in said second chamber when the discharge pressure of said pump reaches a predetermined pressure.

10. A pump mechanism as defined in claim 9 wherein said member has a cylindrical surface at said inner end having a radius of curvature equal to that of the cylindrical wall of said cylindrical chamber and which is adapted, when said member is in said first position, to substantially form a continuation of said cylindrical wall.

11. A pump mechanism as defined in claim 9 wherein said member has a cylindrical surface at said inner end having a radius of curvature equal to that of the cylindrical wall of said cylindrical chamber and which is adapted, when said member is in said first position, to substantially form a continuation of said cylindrical wall but is spaced slightly radially outwardly from said cylindrical wall to provide limited flow between said surface and the outer edges of said vanes and insure the application of liquid pressure to said surface.

12. A pump mechanism as defined in claim 9 wherein said member has a dimension measured at right angles to said axes substantially equal the greatest cord of a sector defined by three adjacent vanes.

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